USING SATELLITE REMOTE SENSING TECHNOLOGY TO MONITOR AND ASSESS ECOSYSTEM INTEGRITY AND CLIMATE CHANGE IN CANADA'S NATIONAL PARKS

PROPOSAL TO THE GOVERNMENT RELATED INITIATIVES PROGRAM OF THE CANADIAN SPACE AGENCY

Submitted by

PARKS CANADA AGENCY

and

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Executive Summary

USING SATELLITE REMOTE SENSING TECHNOLOGY TO MONITOR AND ASSESS ECOSYSTEM INTEGRITY AND CLIMATE CHANGE IN CANADA'S NATIONAL PARKS

Parks Canada Agency (PCA), Canada Centre for Remote Sensing (CCRS) and University of Ottawa are pleased to submit this proposal to the Government Related Initiatives Program (GRIP) to develop indicators to monitor and assess Ecosystem Integrity and Climate Change in Canada's National Parks. The existing GRIP project, 'Engaging Canadians to Achieve Ecological Integrity in National Parks – An Outreach Education Program with Earth Observation Technology' is proposed to be integrated with this proposal, to continue with the important work of outreach and diffusion of the results of the indicator development.

As stated in the National Parks System Plan: "The *Canada National Parks Act* requires that a management plan be prepared every five years. … The first step of the planning process is the production of a *State of the Park Report*, which describes the state of health of the park in the context of the greater ecosystem and the progress made toward achieving the goals of the previous park management plan. Based on the findings of the *State of the Park Report*, a scoping document is then prepared to identify the main issues to be addressed and the proposed time frame needed to complete the plan. Once the Chief Executive Officer (CEO) of Parks Canada has approved the scoping document, the formal management planning activity is launched." PCA plans to use Earth Observation (EO) technology as a fundamental tool in the State of the Park reports to show the status of Ecological Integrity and Climate Change.

Climate Change is a major Government Issue. 'Reducing Canada's Vulnerability to Climate Change' is one of the key programs of the Earth Science Sector (ESS) of Natural Resouces Canada (NRCan) designed to address this priority issue. Promoting the development and application of remote sensing technology to serve public interests is in the mandate of CCRS, as legislated in the NRCan Act.

National Parks are well suited for detecting and monitoring impacts of Climate Change because the effects of anthropogenic stressors are relatively small there. Climate Change is predicted to have a major impact on the biodiversity of many Canadian National Parks as a result of changes in species' ranges, altered disturbance regimes and successional trajectories, increased productivity, and vegetation shifts. The 1997 State of the National Parks report indicated that Climate Change was already causing significant ecological impacts in seven parks, potentially undermining their Ecological Integrity.

This project has a great potential to feed directly into the PCA monitoring program to assess Ecological Integrity (EI) in Canada's National Parks. The project will contribute to PCA's EI Monitoring Program goals by:

- Providing a number of environmental measures that will be combined with other land based measures to develop 6-8 integrated EI indicators for each park
- Developing new approaches and tools to more effectively communicate monitoring results, and
- Establishing standardized monitoring protocols at national, bioregional and park-level scales.

Parks Canada Agency recognizes the value of remote sensing for EI monitoring, and has made a long term commitment to monitoring park Ecological Integrity. As a result, there is a high level of interest in developing geospatial data visualization products to monitor EI and communicate with a wider audience. Because this project is in line with PCA corporate orientation and with the National Parks Action Plan regarding Ecological Integrity, this project has a high probability of sustaining itself after its implementation phase. The project plan includes 'Operational Earth Observation (EO) Capacity Building' so that on completion of the GRIP project, PCA will be ready to begin on-going operational monitoring of the National Parks using EO technology.

The economic impact and benefits will take the following forms:

a. software product sales;
b. improved decision making;
c. industrial contracts;
d. training/human resource development; and
e. improved fulfillment of PCA's mandate for monitoring and managing EI.

PCA and CCRS expect that through this project, our working relationship will continue to grow and find new avenues for collaboration. PCA is actively working with CCRS to finalize a Memorandum of Understanding between the two organizations.

The collaboration between PCA and the University of Ottawa is also expected to grow and prosper. Parks Canada already works closely with the Department of Geography at the University of Ottawa.

Canada is a collaborating member of the International Polar Year (IPY) 2007-2008. Through the CSA GRIP project, Parks Canada will have the opportunity to demonstrate EO products related to monitoring of Arctic ecosystems and landscape to the IPY community. This is just one example of the type of international partnerships that will be aided substantially by the capabilities developed during the GRIP project.

PCA and CCRS bok forward to working with the Canadian Space Agency on this exciting 3-year project.

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1 LINKAGES TO GOVERNMENT ISSUES AND PRIORITIES

D) The Project is strongly linked to a major Government Issue and an identified initiative and addresses a key Departmental Priority by building on existing developments.

The Speech from the Throne of 2 February 2004 said: "Canadians, as stewards of vast geography and abundant resources, feel a keen sense of responsibility to help the world meet the environmental challenge." The speech also reiterated the importance of Climate Change as a major Government Issue. Parks Canada Agency (PCA) believes that national parks are ecological benchmarks that allow the government to measure the effect of Climate Change and other ecological stresses in natural environments. In turn, these measurements will provide for better understanding of Canada's ecosystems and how they are changing. This is a great Canadian contribution "to help the world meet the environmental challenge".

As stated in the National Parks System Plan: "The *Canada National Parks Act* requires that a management plan be prepared every five years. … The first step of the planning process is the production of a *State of the Park Report*, which describes the state of health of the park in the context of the greater ecosystem and the progress made toward achieving the goals of the previous park management plan. Based on the findings of the *State of the Park Report*, a scoping document is then prepared to identify the main issues to be addressed and the proposed time frame needed to complete the plan. Once the Chief Executive Officer (CEO) of Parks Canada has approved the scoping document, the formal management planning activity is launched." PCA plans to use Earth Observation (EO) technology as a fundamental tool in the 41 *State of the Park Reports* and the biannual *State of the Parks and Heritage Areas* report, to show the status of Ecological Integrity and Climate Cha nge.

As stated above, Climate Change is a major Government Issue. 'Reducing Canada's Vulnerability to Climate Change' is one of the key programs of the Earth Science Sector (ESS) of Natural Resouces Canada (NRCan) designed to address this priority issue. The proposed work includes contributions to the monitoring and assessment of Climate Change impact on the Ecological Integrity of Canada's national parks. This collaboration between PCA and Canada Centre for Remote Sensing (CCRS) represents a partial fulfillment of CCRS's mandate of "promoting the development and application of remote sensing technology to serve public interests", as legislated in the NRCan Act.

National Parks are well suited for detecting and monitoring impacts of Climate Change because the effects of anthropogenic stressors are relatively small there. Climate Change is predicted to have a major impact on the biodiversity of many Canadian National Parks as a result of changes in species' ranges, altered disturbance regimes and successional trajectories, increased productivity, and vegetation shifts. The 1997 State of the National Parks report indicated that Climate Change was already causing significant ecological impacts in seven parks, potentially undermining their Ecological Integrity.

2 EO DATA USE AND INTEGRATION

C) The project will result in a major increase in the use of EO data and derived information products in Canada for the intended application(s), which is state of the art and the information is fully integrated OR which is beyond the state of the art but the information is not fully integrated.

This project has a great potential to feed directly into the PCA monitoring program to assess Ecological Integrity (EI) in Canada's National Parks. The project will contribute to PCA's EI Monitoring Program goals by:

- Providing a number of environmental measures that will be combined with other land based measures to develop 6-8 integrated EI indicators for each park
- Developing new approaches and tools to more effectively communicate monitoring results, and
- Establishing standardized monitoring protocols at national, bioregional and park-level scales.

The PCA reporting framework includes 'State of the Park Report (SOPR)' which must be produced for **each** park every five years and the State of Protected Heritage Areas (SOPHA) Report where is to be produced nationally every two years. The new products and information developed by this project will form a major component of future SOPRs and SOPHA Reports. In addition, the EO-derived information will be use internally by PCA for the on-going national monitoring program (at national, regional and local levels), and communications with stakeholders associated with conservation issues.

CCRS and PCA designed the main information products, based on PCA's ecosystem integrity monitoring framework, to be:

a. Habitat fragmentation (a stressor indicator). An implementation method will be developed to quantify habitat fragmentation over time in the past and the future, using products from existing GRIP land cover projects and other data sources.

b. Succession/Retrogression (an ecosystem function indicator). This indicator will track the change of frequency and size in vegetation age class, including trends in the past and updates every five years for each park, using remote sensing data.

c. Ecosystem Vegetation Productivity (an ecosystem function indicator). This indicator will track changes in ecosystem vegetation productivity, including trends in the past and updates every five years for each park, using a remote sensing-based modeling approach.

d. Species Richness (a biodiversity indicator). This indicator will track changes in species richness, including trends in the past and updates every five years, using a remote sensing-based modeling approach. It will mainly carried out by Ottawa University, and CCRA will play a liaison role.

These indicators complement but do not overlap with existing land cover/land use developments in other government departments (OGDs). They are state of the art indicators and they will be fully integrated.

3 OPERATIONAL READINESS AND LIKELIHOOD OF IMPLEMENTATION

D) Systems exist into which this development would feed, Canada will have access to the required data, and the required infrastructure is in place to support the use of the EO data.

By the end of the GRIP project (31 March 2007), PCA will be ready to roll out the monitoring of the indicators using EO technology operationally. Each National Park will be monitored over five years. Considering the growing number of National Parks, and the fact that cloud cover can prevent acquisition of data for each target site in a given year, the plan will be to monitor 12-14 National Parks each year starting in fiscal 2007/08. The schedule for this proposed project is timely in that Parks Canada is in the process of revising park EI monitoring measures and SOPR reporting. To meet targets established by PCA Executive Board, park-level monitoring programs need to be in place by 2008, and operational products from this proposed project will be available in 2007. This products developed form this proposed project will be ready for full implementation and integration into operational park monitoring by the 2008 deadline.

The project will focus on 6-10 National Parks (see Appendix E) that have well-established monitoring plans and good linkages with the park reporting and management cycle. These parks have been chosen to represent a wide range of regional-scale ecosystems across the Parks Canada system. The selection also considered the maximum chances of success, and the capacity for showing results and products to park managers, senior managers, and Executive Board. Readiness of each park will depend on the engagement of park scientists and managers to adopt a common vision and use of EO.

CCRS has already developed algorithms that provide the basis for the proposed development.

Regarding data, past studies will use the Landsat archive, which goes back thirty years. In particular, PCA will use the 1990 digital Landsat mosaic of North America which was created by the United States Geological Survey (USGS) and the Landsat orthorectified images of Canada, produced by NRCan (see the status of recent Landsat 7 images of National Parks in Appendix F). In addition, archived images of individual parks will be sought around 1985 and 1995. This will provide five-year intervals of past history. Landsat is not reliable for the future, but the European Commission has committed to fund SPOT satellites for at least ten years into the future. Other optical satellites, including IRS, Aster, and future hyperspectral missions, will also be considered. CCRS has the expertise to cross-calibrate the data of any two optical missions. Canada has the infrastructure to receive this data. SPOT-5 data is purchased from Iunctus in Lethbridge, Alberta. CCRS proposes to explore the use of Radarsat to provide information on patch structure in areas where an ETM+ replacement image cannot be acquired under operational conditions, such as cloud cover.

As operational methodologies and procedures are developed by the proposed project, PCA will develop an internal EO remote sensing (EO-RS) capability for long-term, operational

monitoring. PCA will set up a ‘control centre’ for image processing and product dissemination that would service Canada’s National Parks.

4 SUSTAINABILITY

D) The Project demonstrates an excellent and feasible plan for continuation beyond the development stage supported by a strong management commitment to the work and its continuation and enduring linkages beyond the research community.

The Executive Board of PCA has recently committed considerable resources to renewed and redesigned EI monitoring at park-level, bioregion, and national, system-wide scales. This commitment reflects PCA responsibilities to report on park EI to all Canadians. The products to be developed from this proposed project will be instrumental in PCA achieving these operational objectives. Because this project is in line with PCA corporate orientation and with the National Parks Action Plan regarding Ecological Integrity, this project will be sustainable after its implementation phase. The project has support (in-kind and financial contributions) from National Parks Directorate, Ecological Integrity Branch, to pursue this initiative. Furthermore, the project intention will be with the PCA National Monitoring program and reporting framework. Finally, the Executive Director and the PCA Chief Scientist both support the project.

Both PCA and CCRS have a long-term commitment to the project. Once the proposed indicators become operational, PCA and CCRS intend to continue to work together to ensure the continuity of these indicators, and to expand their collaboration by developing other indicators. CCRS and PCA have similar key but complementary roles dealing with the knowledge of our environment, ecosystems and Climate Change.

The collaboration with the University of Ottawa will grow as the project progresses. Land cover initiatives by Agriculture and Agri-food Canada (focusing on agricultural land) and by the Canadian Forest Service (focusing on forests) will allow synergetic linkages for sharing of knowledge and expertise.

5 TECHNICAL RISK

D) Technical risks would appear to be low and this will be confirmed by a planned demonstration early in the Project.

The monitoring techniques for these Ecological Integrity indicators use proven remote sensing tools and tested models. Hence, there is little risk in indicator production. The production of historical EO maps for input to the indicator generation system is also very low risk, given that similar processes are already in place to derive land cover from the same data source (Landsat).

There is some risk in continuing sources of multi-spectral data due to the failure of Landsat ETM+. The team proposes three strategies to mitigate this risk. First, CCRS already has in place algorithms to use Landsat TM as a seamless replacement to ETM+. Second, the team proposes to implement a cross-calibration for other sensors such as SPOT or IRS. Finally, CCRS proposes to explore the use of Radarsat to provide information on patch structure in areas where an ETM+ replacement image cannot be acquired under operational conditions, such as cloud cover.

A demonstration of generation of similar indicators will be performed early in the project to confirm the low risk.

6 TEAM CAPABILITIES

D) The team is fully experienced and has demonstrated success in projects of this nature and scope and brings together a fully committed set of internationally recognized complementary skills which fill well-defined roles and clearly meet Project needs.

PCA has substantial expertise in the monitoring and management of Ecological Integrity (botany, zoology, ecology, management of protected areas, geomatics, etc.), public safety and law enforcement. The project team will include a mixture of professionals and technical staff from the National Office, the Service Centres and Fields Units. However, PCA has limited internal EO–RS resources and expertise. Partnering with CCRS will enable transfer of technology and knowledge.

The proposed CCRS team is fully experienced in EO-RS and has demonstrated success in projects of this nature and scope and brings together a fully committed set of internationally recognized complementary skills which fill well-defined roles and clearly meet Project needs. Over 100 refereed papers have been published by the CCRS team members within last 10 years on topics related to the proposed EO application for monitoring indicators of Ecological Integrity of Canada's National Parks.

The University of Ottawa team members are expert in remote sensing-based modeling of species richness.

This combination of PCA, CCRS and Ottawa University is believed to be a winning team. The collaboration offers advantages for each partner.

See lists of refereed papers and international recognition of key team members in Appendix A.

7 WORK PLAN

D) The Project has presented an excellent and complete work plan which is fully matched to the developments described in all aspects.

Appendix B provides an excellent and complete work plan which describes fully the planned developments, Outreach and Diffusion and Operational EO Capacity Building.

8 NETWORKING AND PARTNERSHIPS

D) The Project builds new or significantly enhances existing strong networks and partnerships who have significant roles in both the planning and conduct of the project and who will bring significant funding to the project. These networks and partnerships will endure and be self-sustaining after completion of the Project.

Thanks to the existing GRIP project, PCA has been working cooperatively with other federal departments working with EO-RS (NRCan CTI, CCRS, CSA and others). PCA is actively working in collaboration with CCRS and finalizing a Memorandum of Understanding between the two organizations.

PCA has joined the Canada Land Cover Initiative (CLCI), again thanks to these new partnerships. As stated earlier, PCA will share knowledge and expertise with AAFC and CFS regarding the use of the 1990 Landsat mosaic for mapping of land cover and other indicators.

The collaboration with the University of Ottawa is expected to grow and prosper. Parks Canada already works closely with the Department of Geography at the University of Ottawa. PCA's traditional stakeholders are in fields such as geomatics, conservation and wilderness protection.

Canada is a collaborating member of the International Polar Year (IPY) 2007-2008. Through the CSA GRIP project, Parks Canada will have the opportunity to demonstrate EO products related to monitoring of Arctic ecosystems and landscape to the IPY community. This is just one example of the type of international partnerships that will be aided substantially by the capabilities developed during the GRIP project.

The project has linkages with other government initiatives that will benefit one another, such as Climate Change. PCA is a member of the Interdepartmental Recovery Fund (IRF) for Species at Risk. Types of projects eligible for funding under the IRF can include (see http://www.speciesatrisk.gc.ca/support/irf_fir/program_e.cfm):

- population and habitat surveys;
- studies on the biology and ecological requirements of the species;
- defining, locating, enhancing, creating and protecting critical habitat;
- developing management guidelines for landowners and land managers;
- assessing the effectiveness of management techniques;
- developing public support;
- environmental education;
- building local capacity for species conservation, and others.

The visualization techniques developed in the GRIP project can support many of these activities.

9 COMMUNICATIONS PLAN

D) The project has an excellent, innovative and pro-active Communications Plan that is coordinated with the CSA and extends to all stakeholders.

At the Corporate level, Parks Canada will continue to focus on the implementation of the Engaging Canadians Strategy, a plan to coordinate all the organization's external communication. In its public education programming, Parks Canada will endeavour to effectively communicate the following messages: the essence or national significance of the national systems of parks, sites and marine conservation areas managed by Parks Canada; the need to ensure their ecological and commemorative integrity; and that these dynamic symbols of Canada are there for each of us to understand, appreciate and enjoy (Parks Canada Agency Corporate Plan 2003/04-2007/08 p.23). See Appendix C for more information.

School curriculum programming is a key priority linked with this proposal. PCA is making a significant program shift in attempting to reach youth who are the stewards of the future. The outcomes of this project can be sent to teachers, curriculum writers and departments of education to provide learning resources that relate to school curricula.

PCA will coordinate its communications with CSA, CCRS and University of Ottawa. It is important to find common links to reach Canadians. The partner organizations will communicate results in a planned way, not on an ad hoc basis. The following mechanisms will be considered: annual workshop, training session, scientific papers, conferences on RS, protected areas, Climate Change, etc.

Communication with the senior management of the partner organizations is particularly important.

The team will communicate with:

Internal

- Senior managers: report card on EI condition and progress on EI goals/objectives from Park Management Plan
- Planning community: assist in scoping management plan reviews
- Scientists and resource managers: report on / evaluate science and resource management programs

External

- Land use partners
- Co-managers
- OGDs
- NGOs
- Local communities
- Visitors
- Academia.

10 ECONOMIC IMPACT AND BENEFITS

C) The development is likely to lead to economic benefits from the greater use of information derived from EO data, and limited value-added information services; commercial spin-offs; products; or training/human resource development.

The economic impact and benefits will take the following forms:

a. software product sales;
b. improved decision making;
c. industrial contracts;
d. training/human resource development; and
e. improved fulfillment of PCA's mandate.

Software product sales are expected from the new indicators that will be developed. This is similar to the GeoComp-N product being sold by PCI. It is aimed at monitoring vegetation dynamics. GeoComp-N was developed as a software solution, from work with CCRS. It arose as a combination of research results (field work etc) and industrial know-how. GeoComp-n has been sold to U.S. universities and China. Initially, it used AVHRR; now it may include MODIS too. The expertise includes calibration, bi-directional correction and atmospheric corrections.

Improved decision making will result from better knowledge of the state of Canada's National Parks and their greater ecosystems, including evidence of Climate Change. This is difficult to quantify, but the value of the National Parks as relatively pristine wilderness makes them important as benchmarks. Therefore, the new information gleaned from the indicators will add to our knowledge of the natural environment. This will feed into our decisions about government policy, as well as decisions by companies and individuals.

As shown in **Error! Reference source not found.**, contractors will be hired by PCA and CCRS. This will result in new revenue and skills for industry.

PCA will have staff or contractors in place to run the EO operational control centre. These individuals will learn new skills and develop their potential.

The new EO-based indicators will improve the quality of PCA's fulfillment of its departmental mandate.

11 IMAGE AND AWARENESS

C) The Project will create a number of significant image and awareness benefits.

The project will enhance the image of Canadian EO capabilities (government and industry), of the Canadian government and of Canadian industrial sectors (forestry, agriculture, etc.) at home and abroad by making the new State of the Park reports more graphically oriented and based on improved science of the synoptic situation.

This project has the potential to become an 'eye opener', not only to Canadians but to the international community. PCA, through its network in the international scene (IUCN, Man & Biosphere reserve program, World Heritage Sites, etc.), has the opportunity to demonstrate how EO–RS can be used effectively for managing Protected Areas and contribute in the decision making process. Since some National Parks are part of the UNESCO Biosphere Reserves Program and others are members of the World Heritage Sites Program, the visualization products derived from the GRIP project will receive positive exposure on the international arena.

The project will increase awareness by Canadians, and by senior management in government, of EO capabilities in addressing issues of public concern and in providing government services in the ways described in Section 9 Communications Plan, and Appendix C. PCA and CSA will enhance the image of the National Parks by showcasing 'Virtual visits' of some of the most representative National Park landscapes. The experience of park visitors and public education will be significantly improved with the great help of EO-RS technologies.

EO-RS capabilities will be included in the Parks Canada national school curriculum project.

All of this will lead to greater appreciation of wilderness spaces by Canadians.

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Parks Canada Teachers Resource Centre: http://pc.gc.ca/edu/index_E.asp

Species at Risk Interdepartmental Recovery Fund: http://www.speciesatrisk.gc.ca/support/irf_fir/program_e.cfm

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The World Conservation Union: http://iucn.org

13 Acronyms

AAFC	Agriculture and Agri-food Canada
BOREAS	Boreal Ecosystem-Atmosphere Study
CCAF	Climate Change Action Fund
CCRS	Canada Centre for Remote Sensing
CEOS	Committee on Earth Observation Satellites
CFS	Canadian Forest Service
DOE	Department of Energy (US)
EI	Ecological Integrity
EO	Earth Observation
EO – RS	Earth Observation – Remote Sensing
ESS	Earth Science Sector, Natural Resources Canada
EU	European Union
GOFC	Global Observation of Forest Cover
IGOS-P	Integrated Global Observing Strategy Partners
IPCC	Intergovernmental Panel on Climate Change
IPY	International Polar Year
IRF	Interdepartmental Recovery Fund
JPL	Jet Propulsion Laboratory
LAI	Leaf Area Index
NASA	National Aeronautics and Space Administration
NP	National Park
NPP	Net Primary Productivity
NRCan	Natural Resources Canada
NSERC	National Science and Engineering Research Council
OGD	Other government departments
PCA	Parks Canada Agency
RS	Remote Sensing
SOPHA	State of Protected Heritage Areas
SOPR	State of the Park Report
TCO	Terrestrial Carbon Observation
UN	United Nations
USGS	United States Geological Survey
WBS	Work Breakdown Structure
WGCV	Working Group on Calibration and Validation (of CEOS)
WP	Work Package

Appendix A: Lists of Refereed Papers and International Recognition of Team Members

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Dr. Chen is currently Acting Section Head, Environmental Monitoring Section, CCRS/ ESS/NRCan, and a project leader for the ESS/NRCan Climate Change project entitled "Monitoring Methods and Assessment of Carbon Sequestration over Canada's Landmass". He is also principle investigators of a number of externally funded projects, with many OGDs (e.g., Canadian Forest Service, Statistics Canada, Environment Canada), universities (e.g., Fluxnet-Canada) and international (e.g., JPL/NASA) collaborators. He has served as an expert reviewer for the IPCC 3rd assessment report (WGII), the IPCC Special Report on LULUCF, and the IPCC Good Practice Guidance Report. He was also invited to serve on a NASA review panel on carbon and methane proposals. Currently, he is a science committee member of the Fluxnet-Canada Research Network, a committee member of the Canadian Council of Forest Ministers under criterion 4: forest ecosystem contributions to global ecological cycles, a member of the committee for Environmental Industry Survey of Statistics Canada and Industry Canada, which surveying the technological advancement and application for Climate Change mitigation and adaptation. He is closely involved with the Terrestrial Carbon Observation (TCO), a UN Integrated Global Observing Strategy Partners (IGOS-P) initiative.

Rasim Latifovic is Physical Scientist at Natural Resources Canada, Canada Center for Remote Sensing, Ottawa, ON. His current research includes the application of multi temporal and multi resolution satellite data, including all other aspects of remote sensing for environmental impact assessment and monitoring. He received the B. Sc in Mining Engineering from the University of Tuzla in 1982 and the M. Sc. degree in Technical Science from the University of Belgrade in 1989. Presently pursuing the PhD degree at the University of Laval Quebec City. Until 1995, he taught at the University of Tuzla, and carried research in the areas of mathematical modeling in geology and mining, descriptive geometry, mapping and computer graphics.

Dr. Fernandes was a Canadian Representative to the CEOS Land Parameter Validation Group (2 Invited presentations). He was a reviewer for the NASA Ecocology and Carbon National Research Announcement (paid by NASA). He was a Scientific adviser to National Science Foundation/Environmental Protection Agency BOREAS Follow On Study and Co-Investigator of NASA IDS Proposal for Canadian Cryosphere Monitoring. He was Co-Investigator of ESA Expert Support Laboratory Global LAI mapping and Co-Investigator of European Union VALERI Land Parameter Validation project.

Dr. Fraser was a former NASA Earth System Science Fellow at Yale University and is now a research scientist in the Environmental Monitoring section at the Canada Centre for Remote Sensing. He led the CCRS project "Boreal Wildfire Monitoring and Mapping", which included: development of NRCan's award-winning Fire M3 System with the Canadian Forest Service; partnership in the Global Burned Area 2000 initiative with Joint Research Centre of the EU and seven other agencies; partnership in the joint project "Development of Long Term Inventory of Fire Burned Areas and Emissions of North America's Boreal and Temperate Forests" funded under NASA's Land Cover / Land Use Change Program; and contributions to the GOFC/GOLD Fire Program, including plenary conference presentations and technical program committees. Fraser has published 18 articles in numerous remote sensing and ecology journals and peer-reviewed 23 journal publications, as well as proposals for NASA and NSERC. He has received seven government and industry awards, including the 1998 Head of the Public Service Award.

Dr. Wang: Canadian Representative to CEOS/WGCV/LPV group. Co-Investigator for BOREAS model intercomparison studies. Co-Investigator for U.S. DOE Throughfall Displacement Experiment Project modelling group. Scientific Authority for joint research contract with Harvard University on Satellite Data Collection in Boreal Forest. Principle Investigator for CCAF project of Surface Albedo Simulation and Validation for Climate Modeling: Improvements through Remote Sensing Products.

Dr. Currie is Professor of Biology and Chairman of the Biology Department at the University of Ottawa. He received his PhD in freshwater ecology from McGill University in 1983, and he did post-doctoral research in biostatistics at the University of Montréal. His current research focuses on variation in the structure (e.g., diversity, species composition) and function (e.g. primary productivity) of ecosystems over broad geographic scales, and the extent to which those variables are influenced by human activities. Recent work in Dr. Currie's lab has examined questions such as: is biodiversity in natural systems strongly dependent upon measures of disturbance? Is diversity related to climate in a consistent way among biogeographic regions? What is the difference between areas where rare or endangered species persist, versus areas where they have been lost? Are losses of species from Canada's national parks mainly related to habitat modification, or to other variables? Dr. Currie collaborates with researchers from Parks Canada, the National Centre for Ecological Analysis and Synthesis in Santa Barbara CA, the U.S. Department of Agriculture, and the University of New Brunswick. He is currently editor-in-chief of *Global Ecology and Biogeography*, an international journal specializing in issues of macroecology (broad-scale patterns in ecosystems) and Climate Change.

Dr. Kerr is an internationally recognized leader in biodiversity research. His work focuses on the development of predictive models at a variety of spatial scales that link the distribution of species to major environmental gradients. His expertise in this area has led to a series of invited presentations (e.g. plenary speaker at Canadian Society of Zoologists) and scientific workshops (e.g. NSF, EU, and privately sponsored meetings in California, Austria, UK, etc.). Professor Kerr's work is highly cited and has appeared in the most prestigious scientific journals, including Nature, PNAS, Trends in Ecology and Evolution, Ecology, Ecological

Applications, Conservation Biology, and others. Dr. Kerr has also received major scientific awards, in particular the Governor General's Gold Medal for outstanding Ph.D. research in 1999. He conducted postdoctoral studies in Oxford with Lord Robert May, the President of the Royal Society, and developed advanced expertise with remote sensing data as a research scientist at the Canada Centre for Remote Sensing before accepting an academic position at the University of Ottawa. Professor Kerr is a reviewer for several research agencies (NSERC, National Geographic Research, NERC in the UK) and for major journals, including Science, PNAS, Trends in Ecology and Evolution, the Royal Society journals, Ecology, Ecological Applications, American Naturalist, Conservation Biology, International Journal of Remote Sensing, Canadian Journal of Forest Research.

Appendix B: Work Plan

Quantifiable Objectives and Outputs
The project objectives are:

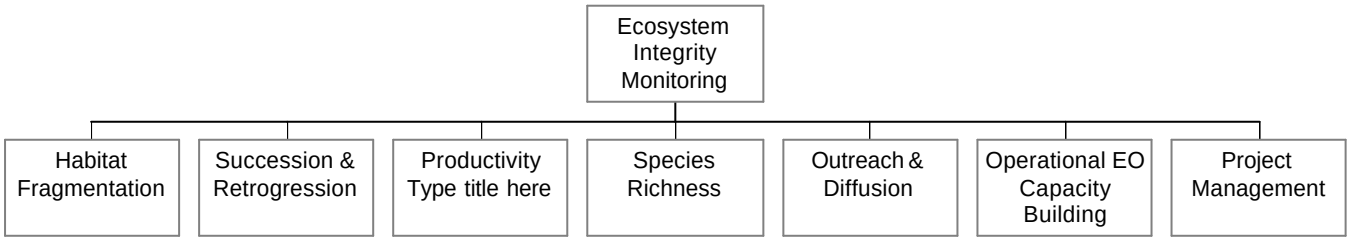
- To develop operational methodologies for using EO-RS to generate monitoring measures of Ecological Integrity and Climate Change impacts in and around Canada's national parks, as defined by the Parks Canada's Ecological Integrity Monitoring Framework.
- To foster a lasting partnership among PCA, CCRS, and Ottawa U. to enable successful implementation of the methodology and ready adoption to changing availability of EO-RS data sources.
- To develop a successful outreach program to communicate project results.

The outcomes will be:

- A set of measures of Ecological Integrity which will be integrated into comprehensive park EI indicators and operationalized.
- An operational control centre ready to launch operations in April 2007.
- Better information about changes in the ecological health and Climate Change in Canada's National Parks.
- Greater awareness of the value of Canada's National Parks by Canadians.

Work Breakdown Structure
The Work Breakdown Structure (WBS) is shown in Figure 1.

Figure 1 Project Work Breakdown Structure



Work Package Descriptions, Milestones and Deliverables
Descriptions of each major work package (WP), milestones and deliverables follow.

WP 1. Habitat Fragmentation Measure

Habitat fragmentation refers to the size, connectivity and arrangement of landscape units that serve as wildlife habitat or pathways between wildlife habitats. The extent of habitat fragmentation can change over time due to natural succession and disturbances (e.g. mortality, insect outbreaks, fires), human activity (e.g., road building), and climate related impacts (e.g. ice melt). A measure of habitat fragmentation serves both as a primary index of

the cumulative effect of these impacts on the park ecosystem structure and as an input to biodiversity assessments and mitigation planning in the face of non-natural disturbances. Essentially, a temporal fragmentation index is required to separate natural disturbance impacts from human and climate impacts on ecosystem services within parks. The team proposes to develop operation tools to produce six standard habitat fragmentation indices (e.g. Iverson 1998) from a variety of existing spatial data and specifically from a range of EO data sources. Significantly, we propose to train park managers in the use of these tools and to showcase the outputs from these methods to the public to raise their awareness. This fragmentation index will serve as a "transfer function" relating observed disturbances catalogued in the disturbance measure with trends in biodiversity to be assessed with the proposed biodiversity measure.

Milestones

FY 1 Baseline fragmentation indices produced for circa 2000.
FY 2 Historical time series of indices produced for circa 1990, 1995.
Algorithms for operational generation of ongoing indices produced.
FY 3 Operational system developed and tested for ongoing monitoring.
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Deliverables:

1. Tools for operational derivation of six standard habitat fragmentation indices (e.g. Iverson 1998) as well as for specification of add-on indices.
2. Derivation of baseline fragmentation indices from existing land cover maps over National Parks (generated from GIS survey or other agencies).
3. Development of methodology to track time change in fragmentation indices through use of baseline maps and ongoing EO satellite image acquisitions on a nominal 5-year time frame required by Parks Canada.

WP 2. Succession/Retrogression Measures

Vegetation disturbance caused by natural and anthropogenic factors has the potential to compromise management objectives in Canada's national parks. Large-scale disturbances are also major sources of carbon releases from fire emission, reduced productivity immediately after disturbances, and changes in ecosystem respiration. Therefore, disturbance rates and resultant age-class distribution changes are critical information for accurate quantification of carbon sink to meet the needs of Canada's Climate Change policy-making and international reporting and negotiations.

Major sources of natural disturbance include wildfire, insects and disease, all of which frequently change park terrestrial ecosystems to earlier ecosystem structural stages. These changes create a landscape mosaic of different ecosystem structural stages, which maintains a range of habitats for wildlife. However, shifts in the frequency of disturbance [e.g. wildfire activity from climate warming (+) or fire suppression (-)] can alter this dynamic equilibrium and have a negative effect on habitat diversity. Human-caused disturbances within and

surrounding parks, such as timber harvesting and development, also have a major impact on the integrity of natural habitats and the maintenance of viable species populations within parks. Two related measures of park ecosystem function will be developed that track the extent of major vegetation disturbances and age-class distribution at a 5-year reporting interval. Note that each measure can be reported separately for parks and their surrounding greater ecosystems. (Greater park ecosystems will be defined for individual parks based on consultations with park managers). The disturbance measure will be expressed as the percentage of park and greater ecosystem area affected per year. This measure will be separable by natural and anthropogenic effects. The vegetation age class measure is expressed as the proportional changes in broad age class categories each year within a park and its greater ecosystem.

The disturbance measure will be created in relation to a baseline land cover circa 2000, which is currently being produced from EO data under other GRIP initiatives. The measure will be developed and demonstrated based on time series of historical disturbances between 1985 and 2000. This will allow for an analysis of disturbance trajectories from 1985 to current and future five-year reporting periods. Note that the disturbance maps will serve as a major input to the succession and fragmentation indicators, and these activities will, in turn, be used to produce the biodiversity measure. We will help ensure the continuity of the measures by developing an operational system and demonstrating it over 3 pilot parks for 2005, and then transferring the system to park employees.

Milestones

FY 1: Existing satellite based land cover products (2000) and archived Landsat imagery (1985, 1990, 1995) acquired and re-formatted, and from which historical disturbance trends will be tracked;
Supplemental Landsat based land cover over large (>1000 km2) parks produced for which no 2000 baseline will be available (in conjunction with fragmentation activity);

FY 2: Approach developed to integrate disturbance databases (e.g. fire agency polygons and defoliation surveys) and published methods for EO-based mapping of different disturbance types (wildfire, defoliation, harvesting, etc) to differentiate disturbance types;

FY 3: Operational system for producing five-year updates of disturbance and succession measures from Landsat alternative sources demonstrated for selected pilot parks.

Deliverables

1. A 1985 baseline of vegetation age class distribution developed for each park based on a combination of published EO techniques, wildfire and insect surveys, and inventory data;
2. Maps showing the locations and type of disturbance for each five-year period (1985, 1990, 1995, and 2000);
3. Time series of disturbance measures for selected parks using disturbance maps;
4. Time series for vegetation age-class measure based on disturbance maps.
5. Operational system for producing five-year updates of disturbance and succession measures from Landsat alternative sources for selected pilot parks.

WP 3. Productivity Measure

Vegetation productivity is a key ecosystem function and disturbances, Climate Change, and human activities could substantially impact the net primary productivity (NPP) of park ecosystems. This has the potential to impair the ability of park ecosystems to provide essential ecological services, such as wildlife habitat and biodiversity. NPP is also one of key components of carbon cycle, and thus critical for accurate quantification of carbon sink to meet the needs of Canada's Climate Change policy-making and international reporting and negotiations.

The productivity measure will be expressed as mean annual NPP averaged over a park area for selected national parks. The assessment of NPP will be done for 1985, 1990, 1995, and 2000 at 30 m resolution.

Milestones

FY 1: NPP field measurement data by PCA for selected parks compiled and used to calibrate and test CCRS-developed productivity models.

FY 2: NPP maps developed at 30-m resolution, for selected parks using EO data and other spatial data.

FY 3: user-friendly remote NPP assessment system tested and demonstrated to PCA.

Deliverables

1. Time series of maps of NPP in 1985, 1990, 1995, and 2000.
2. User-friendly productivity indicator monitoring system.

WP 4. Species Richness Measure

Successful maintenance of Ecological Integrity in Canada's National Parks requires long-term, effective conservation strategies for native wildlife species. The preservation of unimpaired ecosystems, with their full complements of species, will also allow National Parks to serve as ecological models that demonstrate goals of restoration or management regimes underway outside the Parks network. However, the National Parks face a variety on ongoing threats that jeopardize their Ecological Integrity and these threats cannot be managed without an advanced monitoring program for biodiversity that helps predict the consequences of particular management strategies. These threats include habitat fragmentation and loss within National Parks and in areas directly surrounding them (e.g. road construction, forestry activities; cf. habitat fragmentation indicator), natural and human-induced disturbances (e.g. fire, insect outbreaks; cf. disturbance measure), the proliferation of exotic and invasive species, and Climate Change.

The team proposes to develop an integrative biodiversity measure that estimates the current distribution of vulnerable or flagship species within park ecosystems and predicts how different threats will affect them in the future. The approach to be used will be integrative, in the sense that a broad range of data sources will be used to model the likely range for each species in a manner that is similar to, but more complete than, a GAP analysis prediction. These data sources include especially EO-based outputs from the fragmentation and

disturbance measures (e.g. high resolution land cover data, age structure of park ecosystems), observed climatic changes during the 20th and early 21st centuries, land use change data, and observations of species presences within and near Parks. The biodiversity measure will be established by demonstrating the system within approximately six parks. Once it is operational, all software, data, and user guides required to operate the measure will be transferred to park managers, who will be thoroughly trained in their use. Index 1: Change in the predicted range area of flagship species related to climatic and land use changes within National Parks and their greater park ecosystems. Index 2: Change in the predicted range area of invasive species of particular concern within National Parks and their greater park ecosystems.

The species richness measure will be developed and tested by back-casting predictions of species distributions wherever sufficient data sources can be secured (cf. disturbance and fragmentation measures). This will allow for observation of shifts in species distribution through time to be documented and compared with existing historical records.

Milestones

FY 1: In consultation with park staff, collect data on the distribution of target species; Build user-friendly GIS system (with user interface) to generate and test biodiversity data and map outputs;
Identify and begin collecting critical geospatial data relevant to focal species.

FY 2: Begin processing of disturbance, fragmentation, climate, and land cover data for parks (cf. disturbance and fragmentation measures) to generate species distribution data for each measure;
Field tests of cross-section of species distribution predictions.

FY 3: Begin publication and roll-out of operational biodiversity measures for designated parks and generate a series of public exhibits for distribution through Parks facilities; Integrate Landsat replacement data sources into operational species distribution prediction system;
Field tests of species distribution predictions.

Deliverables

1. A 2000 baseline of target species' modeled distributions for designated parks.
2. Changes in the predicted distributions of target species for each five-year period (1985, 1990, 1995, and 2000).
3. Time series of biodiversity measures (area of species' range and total species richness per pixel per park) between 1985-2000.
4. Operational method for producing five-year updates of predicted species distributions and biodiversity measures for designated parks.

<u>WP 5. Outreach and Diffusion</u>

The second and third years of the current GRIP Project "Engaging Canadians to Achieve Ecological Integrity in National Parks – An Outreach Education Program with EO Technology" is proposed to be integrated into this enlarged project.

The Outreach and Diffusion WP is important because it will better communicate sound science to Canadians. Effective communications will be used to demonstrate EO applications by the National Parks EI Monitoring Program. This will communicate the integration of EO and Ecological Integrity to our stakeholders. This approach means more efficient use of money, expertise and capacity. The PCA web site will highlight the new indicator products periodically.

Phase 1 of "Engaging Canadians to Achieve Ecological Integrity in National Parks – An Outreach Education Program with EO Technology" has provided the foundation to access the proper level of EO technology and to link to PCA's long-term National Parks EI Monitoring Program.

PCA will use the new products to communicate key messages of the values of National Parks to public and stakeholders. 'Virtual Visits' of selected National Parks will be a new tool in these communications.

The derived products will provide resource managers and decision-makers with the information to report and forecast the effects of alternative management scenarios. Existing long-term data will be able to be integrated into visualization products and promoted for teaching and research.

Showcase products will be available for the International Polar Year (IPY) 2007-08.

Milestones

FY1: Integration with the on-going development of a national School Curriculum in Parks Canada.
Development of a 'state of the art' fly-through for 2 National Parks with a change detection/spatio-temporal landscape study (link with WP 1: Habitat Fragmentation Measure).

FY2: Popularization of each sub-component project for optimizing Outreach Educational Program content.
Development of a 'state of the art' fly through for 2 National Parks with a change detection/spatio-temporal landscape study (link with WP 2: time series of vegetation map and disturbance maps).

FY 3: Crosswalk output from each sub-component projects for optimizing Outreach Educational Program content.
Development of a 'state of the art' fly through for 2 National Parks with a change detection/ spatio-temporal landscape study (link with WP 3: time series of productivity map or NPP).

Deliverables:

1. Two fly-throughs in National Parks each year for a minimum of 8 after life cycle of the GRIP Project (since two have been created already).
2. Methodology and protocol in place for facilitating production of fly-throughs in other NP's; integration with Web-based Internet/Intranet applications.
3. Material for outreach National Educational Program.
4. Showcase products available for the International Polar Year (IPY) 2007-08.

WP 6. Operational EO Capacity Building

PCA will have staff or contractors to gain expertise in remote sensing applications, ready to operate the EO control centre starting in April 2007. These staff will be trained by CCRS and will follow the progress of the developments at CCRS. They may reside at CCRS for short periods during the training/technology transfer stage.

Office facilities with adequate processing and EO-RS software will be in place for these new staff. Links will be in place so that the output of the control centre can be disseminated to the SOPR team and Outreach team.

Milestones

FY3: Staff or contractors prepared to run the control centre. Office facilities with adequate processing and EO-RS software. Training and technology transfer complete.

Deliverables:

1. Staff and facilities ready for operational launch in April 2007.

WP 7. Project Management

PCA will manage the overall project. CCRS will manage its portion of the work, and will provide the liaison with Ottawa University.

The Project Management will include:

a. planning
b. monitoring and coordination
c. reporting.

Milestones

Not applicable.

Deliverables:

1. Progress reports as required by management.

Responsibilities

The PCA Project Manager will be:

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The CCRS Project Manager will be :

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The Ottawa University Project Manager will be:

Jeremy Kerr
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Appendix C: Communications Plan

This Communications Plan addresses the benefits, impacts and relevance of EO data and derived information products as well as their integration and use in the application area:

- Within PCA.
- To interdepartmental and intergovernmental councils and fora.
- To universities, industry and the Canadian public.

Internal Communications within PCA

The plan for internal communications is as follows:

- A one page newletter to be ciruculated every 3 months
- Annual national workshop
- Intranet coverage of the project progress
- Linkages with existing and planned 'monitoring workshops' held nationally and regionally.

Departmental senior management will be aware of the progress of the project, since it is so central to the implementation of the National Parks EI Monitoring Program.

Education Communications Framework

Description

The Education Communications Framework includes all communication activities that contribute to the acquisition of knowledge about Parks Canada, its mandate and how that relates to Ecological Integrity and Commemorative Integrity, and about the significance of national parks, national historic sites and national marine conservation areas, thereby encouraging understanding, appreciation and stewardship of these heritage places, and support for Parks Canada's role and mandate.

Objectives

- To increase knowledge and understanding of Parks Canada, its mandate, Ecological Integrity and Commemorative Integrity, and of the national heritage systems it manages.
- To educate audiences on the national significance of parks/sites and to strengthen the contribution that parks/sites make to a sense of Canadian identity.
- To connect audiences to their heritage by increasing their knowledge and understanding of the heritage value of individual parks/sites.
- To increase knowledge and understanding of heritage conservation measures at parks/sites and to encourage higher levels of support for commemorative and Ecological Integrity.
- To encourage audiences to take action locally, regionally and nationally in support of heritage conservation.

Engaging Canadians External Communications Strategy

Purpose and Goals

Engaging Canadians is a tool for all Parks Canada staff and managers. This strategy provides agency-wide direction to facilitate co-ordinated and effective external communications. It outlines objectives, key deliverables and specific accountabilities which are reflected in the 2002/2003 Business Plan call letter. Engaging Canadians is intended to assist all levels of the organization in planning, prioritizing and undertaking activities in the development and delivery of communication products targeted to external audiences in support of the agency's mandate. Building upon current strengths, Engaging Canadians is designed to bring about more consistency in how the organization positions itself and what it is responsible for with all constituencies at all levels.

Canadians value national parks, national historic sites and national marine conservation areas of Canada. The more Canadians know about them and appreciate their resources and the issues and challenges they face, the more likely that Canadians will appreciate these heritage places and support the work required to assure their preservation and protection. Engaging Canadians will enable Parks Canada to deliver its priority messages to target audiences in the most effective and efficient manner.

Effective external communications plays a pivotal role in the ability of any organization to fulfill its mission and meet its objectives. The proliferation of new communications technologies, the rise of special interests, and an increasingly diverse and demanding population make the modern communications environment very crowded and complex. Organizations of all kinds, in all sectors, must be concerned, as never before, with consolidating and coordinating all aspects of their external communication activities to project a strong and consistent image, and build loyalty by sustaining meaningful relationships with their constituencies. Engaging Canadians provides for effective communication activities which are the key to the establishment of positive relationships with Canadians.

In the case of Parks Canada, many employees across all functional areas are engaged in a wide variety of activities that in one way or another contribute to how the organization is perceived and that build understanding and support for its mandate and responsibilities. For the purpose of this document, all these activities constitute external communications. The more coherent and consistent external communications are, the more effective Parks Canada will be in meeting its mandate, fulfilling its mission and reaching its policy objectives. The more that external communications are strategic in terms of who is targeted, what is communicated and how, the more likely Parks Canada will achieve optimal outcomes in a timely manner with the resources at its disposal.

The Communication principles for monitoring program are:

- scientifically-defensible – to peers, partners, AG
- targeted – to our reporting responsibilities
- connected - to park management and neighbours
- communicated – to managers, neighbours, all Canadians.

The National Park Monitoring Program stipulates that:

1.Monitoring data needs to be more effectively communicated.

2.Monitoring needs to be better coordinated to eliminate redundancies and facilitate reporting at functional unit (SOPR) and national (SOPHA) scales.

3. The scientific rigour of monitoring programs needs to improve.

Appendix D: Other Related Material with Indirect Links to the GRIP Project

National Parks Network

In November 2002, the federal government announced plans to create 10 new National Parks and 5 new Marine Conservation Areas over the next five years. During this time, Parks Canada also plans to accelerate actions to improve the Ecological Integrity of its 41 existing National Parks. The increase in parkland and efforts to improve Ecological Integrity will implement the action plan of the panel on Parks Canada Ecological Integrity.

The National Parks plan focuses on inventory and monitoring, science-based decision making, developing partnerships, education, and increasing public participation.

Interdepartmental Web Mapping and Visualization Initiative (IWMVI) Vision Statement

This Web Mapping and Visualization Initiative provides some common direction and standards in the federal government to determine a common vision in order to provide executives and managers with a more solid foundation for making informed decisions on their future Web Mapping and Visualization developments. During the development of the Canadian Geospatial Data Infrastructure, the GeoConnections Program has established core capabilities for the discovery and access of geospatial data through the World Wide Web. Federal departments are building on this established foundation to reach out to Canadians who need to receive information from departmental services in a geographical context. The mechanism for delivery of this information and services is through web mapping and visualization (WM&V). Through interdepartmental collaboration, the development of capabilities for WM&V can be shared, thereby saving resources that would be expended otherwise through independent activities.

Parks Canada is a member of the IWMVI working group.

International Polar Year (IPY) 2007-08

The IPY 2007-08 will focus on the polar regions with an holistic approach. This will be a multi-disciplinary effort that will bring in all aspects of any science pertinent to Antarctica and the **Arctic**—including the humanities and social sciences.

Canada is a collaborating member of the IPY.

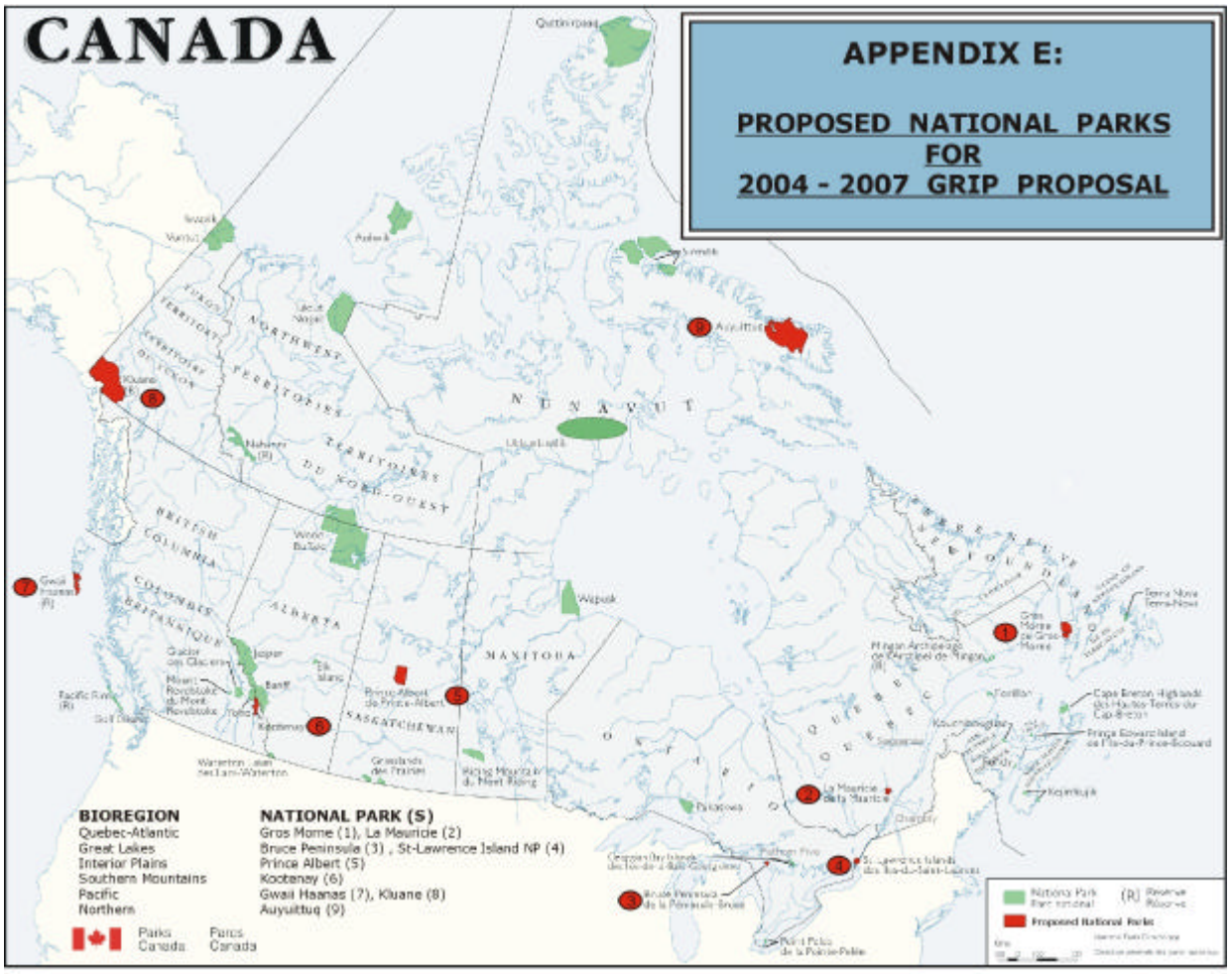
Through the CSA GRIP project, Parks Canada has the opportunity to demonstrate EO products related to monitoring of Arctic ecosystems and landscape. See http://us.ipy.org

Appendix E: Selected National Parks

The following National Parks have been selected as test sites for the project.

Bioregion	National Parks
Quebec-Atlantic	Gros Morne, La Mauricie
Great Lakes	Bruce Peninsula, St-Lawrence Island NP
Interior Plains	Prince Albert
Southern Mountains	Kootenay
Pacific	Gwaii Haanas, Kluane
Northern	Auyuittuq

The next page shows the locations of the National Parks proposed to be monitored.



Appendix F: Status of Landsat-7 Imagery for the National Parks

Table 1 Status of Landsat-7 Imagery of National Parks

Existing National Parks & Reserves	Date(s) of Acquisition	Coverage Level	# of images acquired / Total required # of images
Aulavik	August 1999; August & September 2000	Full	5 / 5
Auyuittuq	August 2000 & 2002	Partial (60%)	2 / 5
Banff	September 2001	Full	3 / 3
Bruce Peninsula	September 1999	Full	1 / 1
Cape Breton Highlands	June 2000 & 2001; September 2001	Full	3 / 3
Elk Island	July 1999 & 2001	Full	2 / 2
Fathom Five	September 1999	Full	1 / 1
Forillon	September 2001	Full	1 / 1
Fundy	September 2000	Full	1 / 1
Georgian Bay Islands	September 1999	Full	1 / 1
Glacier	September 2001	Full	1 / 1
Grasslands	August 1999	Full	1 / 1
Gros Morne	September 2001	Full	2 / 2
Gulf Islands	July 2000	Full	1 / 1
Gwaii Hanaas	September 2001	Full	2 / 2
Ivvavik	August 2001	Full	2 / 2
Jasper	August 2002; September 2000 & 2001	Full	4 / 4
Kejimkujik	June 2001; September 2001	Full	2 / 2
Kluane	None	None (0%)	0 / 2
Kootenay	September 2001	Full	4 / 4
Kouchibouguac	September 2000	Full	1 / 1
La Mauricie	June 2001	Full	2 / 2
Mingan Archipelago	August 2001; September 1999	Full	2 / 2
Mount Revelstoke	August 2000; September 2001	Full	2 / 2
Nahanni	July 1999	Partial (45%)	1 / 2
Northern Bathurst Island	July 2000; August 1999	Full	3 / 3
Pacific Rim	June 2000; September 1999	Full	2 / 2
Point Pelee	August 2001	Full	1 / 1
Prince Albert	July 1999; August 2001	Full	3 / 3
Prince Edward Island	June 2000; August 2001	Full	2 / 2
Pukaskwa	May 2000; October 2000	Full	2 / 2
Quttinirpaaq	July 1999	Partial (50%)	2 / 5
Riding Mountain	July 2001 & 2002; September & October 1999	Full	4 / 4
Saguenay St. Lawrence	Mai 2001	Full	1 / 1
Sirmilik	August 1999 & 2001	Partial (75%)	3 / 4
St. Lawrence Islands	October 1999	Full	1 / 1
Terra Nova	July 2000	Full	1 / 1
Tuktut Nogait	June 2000 & July 1999	Partial (95%)	3 / 4
Ukkusiksalik	July 2000; August 2002 & September 2000	Partial (80%)	3 / 5
Vuntut	August 2001	Full	1 / 1
Wapusk	July 1999; August 2000 & 2001	Full	4 / 4
Waterton Lakes	September 1999	Full	1 / 1
Wood Buffalo	June 2000; July 2001; August 1999; September 2001	Full	5 / 5
Yoho	September 2001	Full	1 / 1
Proposed National Parks	**Date(s) of Acquisition**	**Coverage Level**	**# of images acquired / Total required # of images**
East Arm of Great Slave Lake	June & July 2000	Full	3 / 3
Manitoba Lowlands	July & August 1999	Full	2 / 2
Mealy Mountains	July 2002; September 2001	Partial (85%)	2 / 3
Torngat	August 2002	Partial (30%)	1 / 3